

# Paleoceanographic interpretation of the light rare earth elements

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The rare earth elements (REE) in sea water have been used as indicators of the modern oceanic and paleoceanic environments. The Nd-isotopic composition ( $\epsilon\text{Nd}$ ) of ferromanganese crusts and nodules successfully record water mass changes integrated over  $10^4$  and  $10^5$  years; fossil fish teeth and debris pinpoint water mass changes through the Cenozoic, though also with low temporal resolution due to the scarcity of fish remains [2; 3]. Records of much higher temporal resolution have been produced from the  $\epsilon\text{Nd}$  of bulk sediment leach, and over glacial-interglacial timescales [4]. Isolating the  $\epsilon\text{Nd}$  of seawater from lithogenic contamination, however, is problematic. Detrital contaminants are much more easily removed from planktonic foraminifera and therefore may be more representative of a seawater signal [1]. The phase in which the  $\epsilon\text{Nd}$  is associated with foraminiferal calcite is of critical importance for the paleoceanographic interpretation. In addition to Nd, the full sequence of rare earth elements can speak to diagenetic indicators and bottom-water conditions in which the authigenic signal is acquired. Studies of coupled planktonic benthic REE comparison allow for clear indications of diagenetic overprinting. Here, we present data from the Iberian Margin that demonstrate coherent, diagenetic signals indicative of environmental conditions associated with climate signals. Also, we present data generated using X-ray absorption near edge structure analysis that help to identify fine-scale spatial distribution of high concentrations of REE and also the oxidation state of redox sensitive cerium. With a combination of paleorecords and different analytical approaches, we can begin to identify the distinct phases of the REE and as a result, the paleoceanographic interpretation of these elements.

[1] Elmore, A., A. Piotrowski, and J. Wright (2011), Testing the extraction of past seawater Nd isotopic composition from North Atlantic deep sea sediments and foraminifera. [2] Frank, M. (2002), Radiogenic isotopes: tracers of past ocean circulation and erosional input, *40*(1), 1001. [3] Martin, E., S. Blair, G. Kamenov, and H. Scher (2010), Extraction of Nd isotopes from bulk deep sea sediments for paleoceanographic studies on Cenozoic time scales. [4] Piotrowski, A., S. Goldstein, S. Hemming, and R. Fairbanks (2004), Intensification and variability of ocean thermohaline circulation through the last deglaciation, 225(1-2), 205-220.